MCenter Beamline Improvement Attempts for 2019/2020 Run

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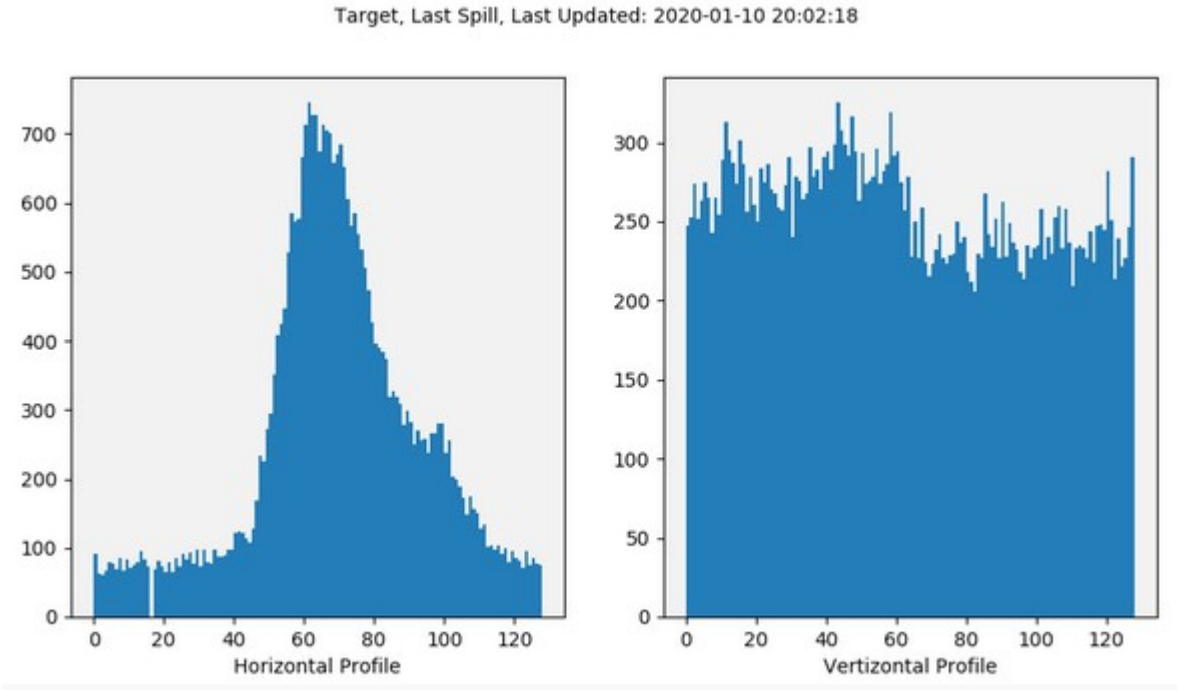
What we've tried so far

For current beam run starting Dec. 2020, the following are operational changes to attempt to improve beam quality.

- Re-tune final triplet in secondary beamline to achieve spot on NOvA target MWPC. (thanks to NOvA TB folks for working on MWPC)
- Target scan on MC6 primary target to maximize secondary beamline coincidence (thanks to NOvA TB folks for getting coincidence counter working). Implement autotune on last two positions in primary beamline for the target (i.e. target position and angle). Nominals could potentially be improved (angle scan).
- Insert upstream MC2 pinhole collimator to clean up primary beam on MC6 target; motor control issues made results inconclusive, but ready to try again.
- Fix failed back-scatter MC6 primary target scintillator to make sure we're hitting the target; in progress.
- Simulate wider MC6 primary target to see if muon halo is improved; in progress.
- Run excess beam in MI to improve spill quality (~6 hours on 2/25/20). Hoping to reduce intensity spikes in beam on detector. Results unclear; NOvA?

NOvA TB target spot tuning

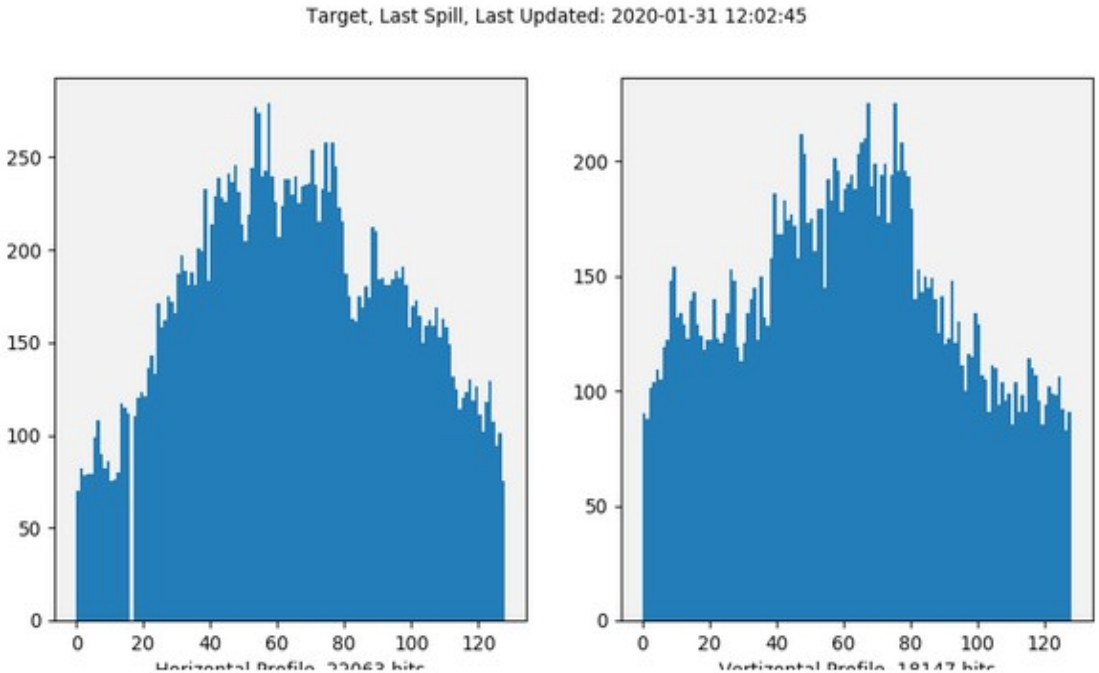
NOvA target MWPC profiles at start of 2020 run. Secondary beamline vertical collimator @ 12.7mm.



Fermilab

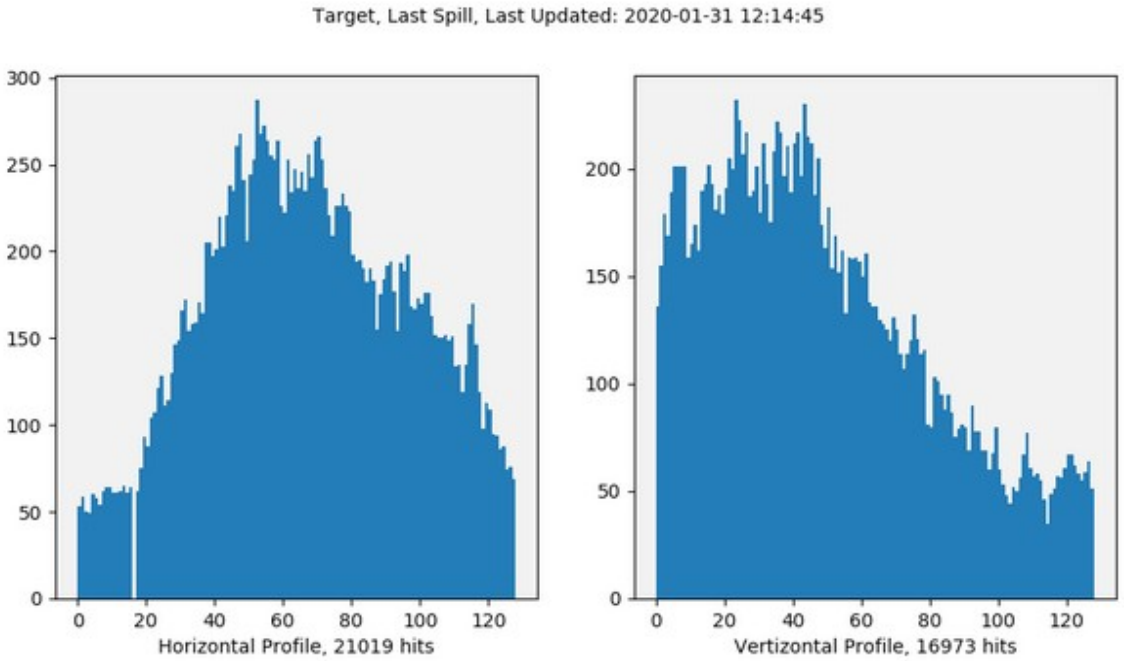
NOvA TB target spot tuning

NOvA target MWPC profiles after re-tuning final focus, collimators closed down to 2.8 mm to see on-momentum secondaries.



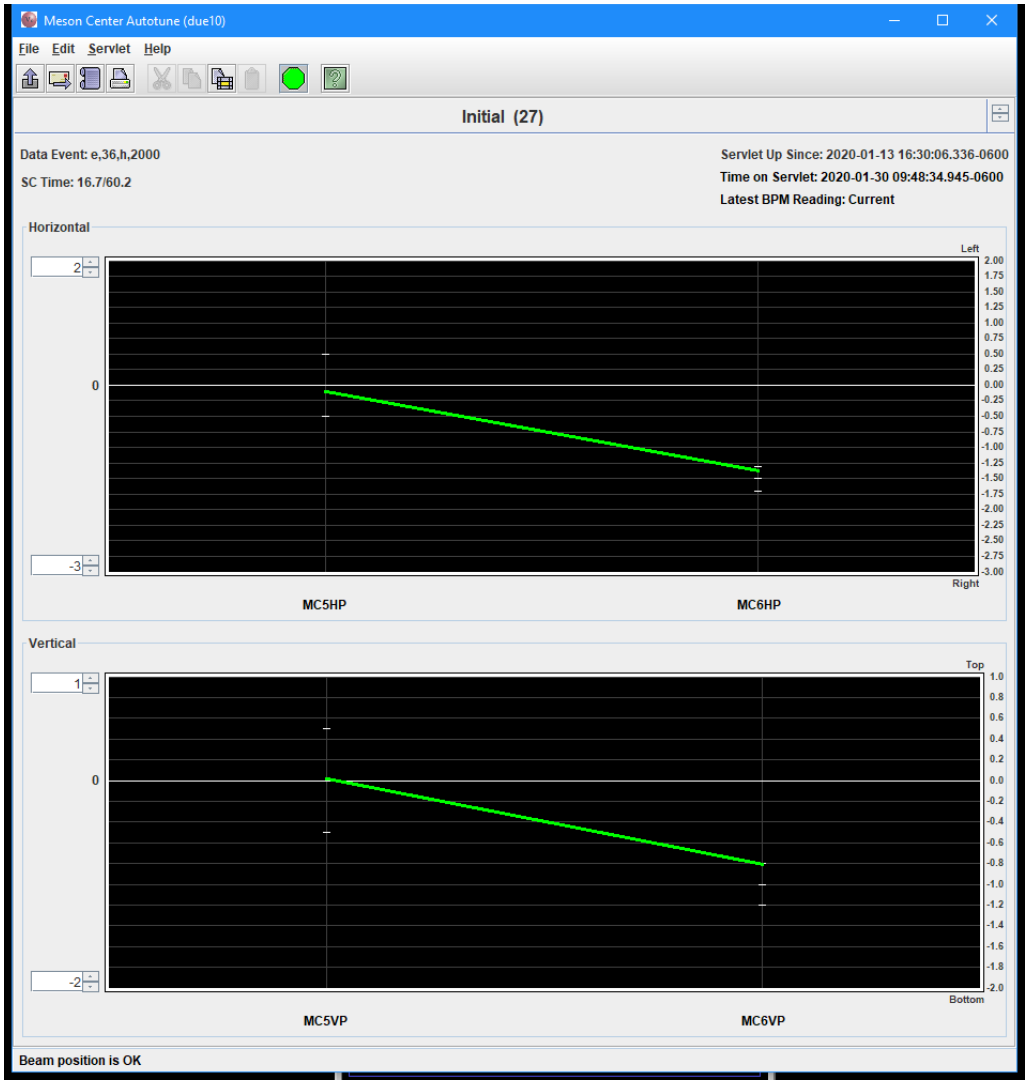
NOvA TB target spot tuning

NOvA target MWPC profiles after re-tuning final focus, collimators open to nominal 12.7 mm. Unclear why this change needed to happen this run.



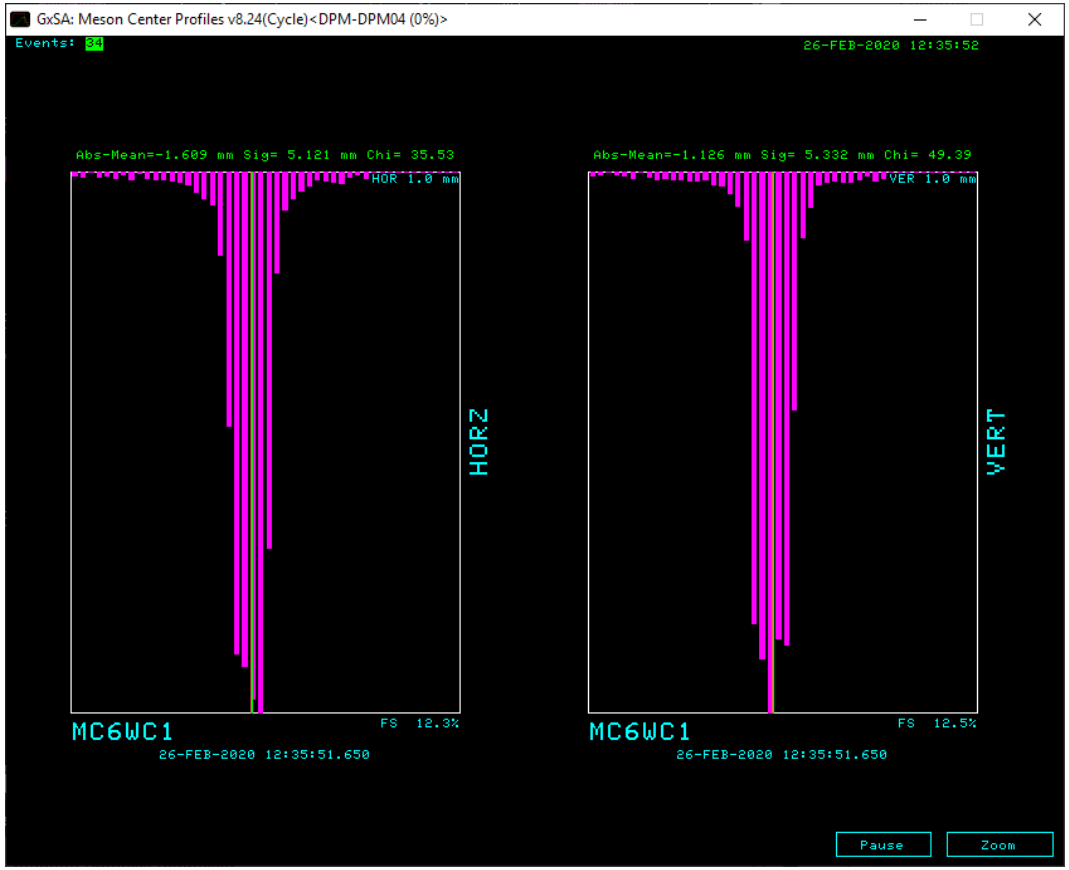
Unclear if this had any effect on the halo (NOvA?). 12.7 mm determined nominal during previous run; may be better way to run by closing down to reduce halo.

Primary (MC6) target autotune



- Autotune now keeps position and angle on primary target consistent.
- Unclear if current nominals for position/angle are ideal.
- Fixing target monitor scintillator is critical before re-scanning.
- Local radiation survey indicates that we're hitting the target; improvements on position are still possible.
- Angle needs to be scanned (pivot about target) to determine if muon halo moves.

Small primary target



- Beam RMS spot size is ~5mm in both planes (PWC wire spacing is 1mm). Could be artificially wider due to back-scatter.
- Target width is 5 mm in both planes.
- Final focus quadrupoles are running quite hard, likely not much tuning room to improve.
- Unclear if halo is better/worse depending on how well we're hitting the target. Some indication from NOvA TB that target tuning to maximize secondary coincidence did affect muon halo.
- Pinhole collimator would force small parallel spot on target, sacrifice rate.

Action items

- Repair and replace MC6 target monitor, re-scan position to make sure we're hitting it optimally.
- Better understanding of experiment metric to tune to; can I watch the halo move/change while I tune the beam angle on the primary target (pivot about the target)?
- Secondary beam momentum scan.
- Pinhole collimator to make smaller beam hit primary target.
- Finish moderate-statistics G4BL runs to determine whether thicker primary target is helpful.
- Close down secondary momentum-selection collimator, determine if reduction in halo is worth reduction in pion rate.